

## Problems on Chapter 6: Other Vertical Coordinates

- Q 6.1:** What is a typical value for the slope of a surface of constant pressure?
- Q 6.2:** If the wind were westerly at  $20 \text{ ms}^{-1}$  at 500 hPa at all latitudes between  $30^\circ\text{N}$  and  $60^\circ\text{N}$ , what would be the difference in height of the 500 hPa surface at those latitudes? State any approximations or assumptions which you need to make.
- Q 6.3:** On a certain occasion at the 700 hPa the lines of constant  $z$  ran from west to east, with low values to the north, and contours drawn at 10 m spacing lay 200 km apart. At 300 hPa the contours had similar spacing but they ran from south to north with low values to the east. Sketch the lines of constant thickness of the 700 to 300 hPa layer and find the value of  $v_T$ . Find also the horizontal temperature gradient.  
(Assume latitude is  $45^\circ\text{N}$ .)
- Q 6.4:** On a certain occasion the wind at 850 hPa was  $15 \text{ ms}^{-1}$  from the NE and the average temperature between 850 and 500 hPa was found to increase to the south at a rate of 4 K per 100 km. Estimate the magnitude and direction of the wind at 500 hPa on that occasion.  
(This temperature gradient has been chosen to be typical of those in frontal regions.)
- Q 6.5:** The poles are about 40 K cooler than the tropics. Estimate (stating any assumptions you need to make) how much larger the westerly component of the wind at 200 hPa can be expected to be on average than that at 1000 hPa.
- Q 6.6:** Prove that if it is observed in middle or high latitudes of the northern hemisphere that the wind “backs” with height, then cold air is blowing towards the observer, and that if the wind “veers” with height, then warm air is blowing towards the observer.  
(Backs=rotates anticlockwise (i.e. goes backwards compared to the sun), veers = rotates clockwise)